It is now proved that the great philosopher occupied an attic in the house, No. 28, Paveljoens-gracht in Doublet Straat, opposite to the Holy Ghost House (hoffje). The house belonged to a Heer van der Spyk. Shortly a marble tablet with a fitting inscription will be placed over the entrance.

THE German Geological Society met at Göttingen in the last week of September. The first lecture was delivered by Prof. Credner, of Leipzig, who spoke on the granite of Geyer. Then Prof. Klein, of Göttingen, spoke on a collection of thin sections of minerals forming rocks.—Herr Levin presented a petrified starfish (*Asteria cilicia*) found by him in the upper Muschelkalk of the Hainberg. This specimen is particularly interesting, being the first starfish which has ever been found in the North German limestone.—A communication was read from Prof. Martin, of Leyden, on the tertiary fauna of Java.—Dr. Hornstein (Cassel) reported on a new treatise on Eozoon by Prof. Möbius (Kiel), which will be published in Parts 5 and 6 of the "Palæontographica." Prof. Möbius arrives at the conclusion, from long-continued investigations of numerous specimens of Eozoon, that the latter is of inorganic nature.—Then followed some minor communications from Herr von Groddeck, Prof. Streng, and Prof. Weiss (Berlin), the latter pointing to a recent discovery of coal in the so-called "Eherne Kammer," some few miles to the south of Eisenach. The other speakers at the meeting were Prof. von Seebach (Göttingen), Herren Grotrian (Brunswick), Römer (Breslau), Schmid (Jena), and Prof. vom Rath (Bonn). The Society will meet at Baden Baden in 1879.

ACCORDING to a communication made at the Berlin meeting of ornithologists by Dr. Brehm, the Crown Prince Rudolf of Austria is about to publish a work on Eagles, in conjunction with Drs. Brehm and von Homeyer.

WE have on our table the following works:—"Commercial Products of the Sea," P. L. Simmonds (Griffith and Farran); "Talks about Plants," Mrs. Lankester (Griffith and Farran); "Notes on a Tour in America," H. Hussey Vivian (E. Stanford); "Philosophical Fragments," Dr. Morell (Longmans); "Geological Survey of Canada: Report of Progress for 1876 and 1877," "The Germ Theories of Infectious Diseases," J. Drysdale, M.D. (Baillière); "Sedimentary Formation of New South Wales," Rev. W. B. Clarke (Trübner); "Annual Report of the Department of Mines of New South Wales for 1877" (Trübner); "Australian Orchids," Parts 3 and 4, R. D. Fitzgerald (Trübner); "Geology of Ireland," G. H. Kinahan (Kegan Paul, and Co.); "Animal Chemistry," C. H. Kingzett (Longmans); "Manuel du Voyageur," D. Kaltbrunner (Würster and Co., Zurich); "Report on the Geological Survey of the United States," Dr. Hayden.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Saimaris sciurea*), from Guiana, presented by Mr. Edward Calthrop; an Emu (*Dromæus novæ-hollandiæ*), from Australia, presented by Mr. C. Hampden Wigram; two Radiated Tortoises (*Testudo radiata*), from Madagascar, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Water Rail (*Rallus aquaticus*), British Isles, presented by Capt. F. H. Salvin; a Michie's Tufted Deer (*Elaphodus cephalophus*), from China; a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*); three Blue-bearded Jays (*Cyanocorax cyanopogon*); a Dark-winged Buzzard (*Leucopternis scotopterus*), from Bahia; a Saturnine Mocking Bird (*Mimus saturninus*); two Lined Finches (*Spermophila lineola*); two Gutteral Finches (*Spermophila gutteralis*), from Pernambuco; a Pileated Song Sparrow (*Zonotrichia pileata*), from Rio de Janeiro; a Palm Tanager (*Tanagra palmarum*), from Monte Video, deposited; a Patas Monkey (*Cercopithecus ruber*), from West Africa; two Ruddy Sheldrakes (*Tadorna rutila*), European, purchased.

ON A NEW METHOD OF STUDYING THE OPTICAL CHARACTERS OF MINERALS[1]

AS is well known, the optical characters of minerals furnish us with a most valuable means for identifying the various species. The practical application of these phenomena has, however, been much restricted by the difficulty of obtaining crystals sufficiently large and transparent to be cut into appropriate sections, so that the properties of some of the commonest minerals were very imperfectly known. By the methods hitherto employed it was almost impossible to study the black or imperfectly transparent minerals constituting the chief part of rock masses, and in fact little could be learned unless the specimens were so large and perfect that the individual species could be identified by other means. What we want is a method which will enable us to ascertain the approximate value of the principal optical constants, when we have at our disposal only detached, small, and imperfect crystals in their natural state, or those scattered about in thin sections of rocks, cut into plates which are inclined at every varying angle to the optic axes.

The method now to be described satisfies these requirements sufficiently well. Time would not permit me to give a full description of the apparatus, the manner of using it, and the conclusions to be drawn from the observed data. I must therefore avoid all unnecessary detail, and confine myself to such an outline as will serve to indicate the general character of the method. I may here say that I have received most valuable assistance from Prof. Stokes in the mathematical part of the subject.

When, many years ago, I first commenced to apply the microscope to the study of minerals, I was told by a well-known professor of mineralogy that it would never be possible to learn much by the use of that instrument. If we merely magnify a portion of a pure transparent crystal, we do, indeed learn little or nothing; but if, instead of viewing the crystal itself, we look through it with a suitable magnifying power at some appropriate object, we can learn more facts of interest and importance than by any other single method whatever. The property possessed by the object-glass of collecting divergent rays to form an image gives rise to an entirely new class of phenomena, and converts the microscope into a most valuable apparatus for optical research. The object examined through the crystals is the image of a small circular hole, or of rectangular lines ruled on a piece of glass, formed at the focal point of a well-corrected achromatic condenser fixed below the stage, and so arranged that the image is placed either just below or just above the lower surface of the crystal. The divergent rays passing through it to the object-glass are bent so that the focal length is, as it were, increased by an amount depending on the thickness of the crystal and its refractive power. In order to see the lines in focus, it is therefore necessary to move back the body of the microscope. If we know the thickness (T) and the amount of the displacement of the focal length (d), we can calculate the value of the index of refraction (μ) from the equation

$$\mu = \frac{T}{T - d}.$$

These values are measured by means of a scale and vernier attached to the body of the microscope; and, with care, there ought to be no error greater than $\frac{1}{2000}$th of an inch. The thickness of the specimen (T) is determined by measuring the difference in the focal points for particles of dust on the surface of the supporting glass and on the upper surface of the mineral. In a similar manner the value of d is determined by the difference in the focal length for the lines of the grating seen through the supporting glass with or without the specimen under examination. From the value of the index thus determined a small amount must be deducted, depending upon the aperture and correction of the object-glass, and, when great accuracy is desired, several precautions must be taken to avoid a number of possible small errors, which it would be tedious to explain in detail.

In the equation, $\mu = \frac{T}{T - d}$, it is assumed that the substance possesses no double refraction, as in the case of glass or crystals belonging to the regular system. When viewed through such a substance, only one simple and undistorted image of the circular hole can be seen, and both sets of lines are in focus at the same adjustment, no matter what may be their azimuth to the axes of the crystal. We obtain by measurements and calculation one single index of refraction, but this may vary so much in different minerals as to clearly point out what they are. Thus, for example, it varies from 1·43 in fluor to 2·34 in blende. If, however, the crystal possesses strong double refraction, the phenomena are far more complex, and vary according to the direction in which the section is cut, its azimuth to the lines of the grating, and also according as it has one or two optic axes.

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[1] Address by the Chairman, H. C Sorby, F.R.S., Pres. G.S., &c., at the meeting of the Yorkshire Geological and Polytechnic Society, held in Selby on March 13.

If we look through a parallel plate of a uniaxial crystal with powerful double refraction, like calcite, cut perpendicular to the principal axis, we see two undistorted images of the circular hole, directly superimposed, one over the other, but separated vertically by a wide interval. This doubling of the image is due to the collection by the object-glass of divergent light, since, for strictly parallel rays passing in the same general direction, there is no double refraction whatever. Both systems of perpendicular lines are seen in focus at the same time in each of the images, one of which is due to the ordinary, and the other to the extraordinary, ray. By observing these focal points we obtain two indices of refraction, one being the true index of the ordinary ray (μ), and the other not that of the extraordinary ray (μ'), but a very low apparent index, equal to $\frac{\mu'}{\mu}$.

When the section is cut in other directions the images differ very much from one another. That due to the ordinary ray has invariably the same properties. The circular hole is not distorted, and both systems of line are in focus at the same time, so that we may call that image *unifocal*. The other image, due to the extraordinary ray, instead of thus maintaining a constant character, changes very greatly, the maximum of change being when the section is cut parallel to the principal axis of the crystal. There is no focal point whatever at which the circular hole is seen of its true size and shape, and the entire circumference is never all in focus at once. There are two special foci, widely separated, at which the circle is, as it were, drawn out into a long band, at one focus parallel, and at the other perpendicular to the axis. If the section be strictly parallel to the axis the focal point of the ordinary image is nearly half-way between these two foci of the extraordinary ray, and coincides in horizontal position with the point at which the two elongated bands intersect. There is thus no lateral displacement of the images. If, however, the section be not parallel to the axis they are displaced laterally, this character being a very delicate test of the accuracy with which the section has been made. In fact, in all cases, if the two opposite surfaces are parallel, the character and position of the images at once indicate the exact relation between the optic axes and the planes of the plate, whether they be natural or artificial.

On viewing the rectangular grating through a section cut more or less nearly parallel to the principal axis, no lines whatever can be seen by means of the extraordinary ray, unless one system is nearly parallel to the axis. At one focal point one system of lines is seen, and at the other focal point the other system, so that the image due to the extraordinary ray may be said to be *bifocal*. On rotating the grating, the lines are seen to become broader, then obscure, and finally invisible. Unlike the image due to the ordinary ray, the bifocal image has thus a special focal axis, and the lines can never be seen in sharp focus if they are not either parallel or perpendicular to this axis.

On the whole, then, we have three focal points, one for the ordinary, and two for the extraordinary ray; and by observing these we obtain three different indices of refraction, one being that of the ordinary ray μ; and, provided that the section is closely parallel to the axis, the index derived from the lines parallel to the axis in the extraordinary image is the true index (μ) of the extraordinary ray, whilst the third index is of the very abnormally high apparent value $\frac{\mu^2}{\mu'}$.

The characteristic peculiarity of crystals like aragonite, which have two optic axes, is that, when the section is so cut that the images are directly superimposed without lateral displacement, they give two bifocal images, and four apparent indices. When cut in particular directions one of these images may become unifocal, but then there is a more or less considerable lateral displacement of the two images. When the section is cut perpendicular to the line bisecting the acute angle between the optic axes, so as to give two very bifocal images, the images of the circular hole are crosses at two different foci, and not, as in the case of calcite, two circles. Biaxial crystals have three true indices of refraction (μ, μ', μ''), and, if the section be accurately cut in the plane of any two of the axes of elasticity, so that there is no lateral displacement of the images, the four apparent indices observed from the lines of the gratings are as follows :—

	Polarised in one plane.	Polarised in the opposite plane.
From lines perpendicular to the plane of polarisation	μ	μ'
From lines parallel to the plane of polarisation	$\frac{\mu''^2}{\mu}$	$\frac{\mu''^2}{\mu'}$

Calling these observed indices *a*, *b*, *c*, and *d* respectively, we thus have $\mu'' = \sqrt{a\,c}$ or $\sqrt{b\,d}$. It follows from this that we can determine the value of all three indices by very simple observations, made by employing a single section cut in the plane of any two of the three axes of elasticity. Absence of lateral displacement in the images at once shows us that the specimen in its natural state, or as artificially cut, is sufficiently parallel to one of these planes to be suitable for the determination of the indices; but even if it is not such as to give all three indices absolutely true, one at least may be correct, and the others may be determined approximately. In any case the character and position of the images at once shows in what direction the section is cut, or the relation which any parallel planes of a natural crystal bear to the optic axes, though the phenomena are more complex than in the case of uniaxial minerals.

It would occupy far more time than can be allowed on the present occasion to describe in detail the curious and anomalous appearance due to dichroism or to the laminar structure of particular minerals which gives rise to complex internal reflections. My chief aim has been to call attention to the very valuable facts which may be learned by viewing a circular hole or rectangular grating with a microscope through a parallel plate of any crystalline mineral. The data thus obtained are so remarkably characteristic that they alone would amply suffice to identify a large proportion of natural minerals. In many cases all the necessary observations can easily be made with small crystals in their natural state, which alone is of course a very great gain for practical mineralogy. The chief value of the method is, however, that it enables us to identify portions of minerals of microscopic size in sections of rocks as thin, or even thinner than $\frac{1}{400}$th of an inch with an amount of certainty which leaves little to be desired.

When examining specimens of such a size that their thickness must be measured by means of the scale attached to the body of the microscope, I find that an object-glass of about $\frac{2}{3}$ inch focal length, combined with a somewhat highly magnifying eye-piece, gives the best results. When, however, we come to study the minerals in moderately thin sections of rocks, it is impossible to measure the thickness and the displacement of the focus sufficiently accurately by means of the scale and vernier. The fine adjustment screw of the microscope may then be employed along with a $\frac{2}{5}$ or $\frac{1}{5}$ object-glass, and, if properly constructed and used, the requisite measurements may be made to within $\frac{1}{20000}$th of an inch. We may thus approximately determine the indices in sections only $\frac{1}{1000}$ of an inch in thickness. It is, however, necessary to adopt a system which reduces the number of separate measurements and to a great extent eliminates several sources of error. Instead of attempting to measure the *absolute* thickness of any particular crystal, and the actual displacement of the focal length due to it, the *apparent* thickness of the mineral, *as seen through itself* (*t*), is measured by means of the rotation of the graduated circular head of the fine adjustment by focussing, first to the top and then to the bottom, of some appropriate specimen. In each particular substance this apparent thickness is equal to the true thickness divided by the index of refraction. The thin glass cover is made somewhat larger than the section, so as to project beyond it, and inclose a layer of the hard and brittle balsam used to fasten down the piece of rock. Selecting for observation a specimen as near as possible to this balsam, so as to avoid any error due to unequal thickness, the difference (d') in the displacement of the focal length due to the mineral and the balsam is ascertained by focussing through each the lines of the grating. This value is positive or negative, according as the index of the mineral is greater or less than that of the balsam. It then follows that $t \pm d'$ is the thickness, as seen through itself, of the amount of balsam of the same real thickness as that of the mineral: the effects of the balsam below and above it, and of the covering-glass, being thus entirely eliminated. If, then, the index of the balsam be *m*, we can easily calculate that of the mineral (μ) from the following equation:—

$$\mu = m \frac{t \pm d'}{t}.$$

In the case of the hard and brittle balsam used to fasten down the specimen, the value of *m* is about 1·54; but if there be any doubt about the true index, it can be ascertained by special measurements.

In a similar manner we may determine the index of some unknown mineral by comparing it directly with some other mineral lying near to it, the true index of which is either well known or has been previously ascertained from special measurements. For this purpose quartz is often very suitable, since its index varies very little. One great advantage of this method is that specimens may be observed far away from the edge of the section, provided of course that the minerals compared are so close together as to prevent any error due to unequal thickness in different parts.

It must be borne in mind that, when any mineral has a very powerful double refraction, its apparent thickness, as seen through itself, varies according to the particular ray used for illumination and the direction of the objects chosen to determine the focal distances of the lower surface. There is, however, generally no difficulty in measuring with sufficient accuracy the mean apparent thickness, or that corresponding to some one image, and in calculating out the results accordingly.

In connection with this subject it may be well to call attention to a somewhat interesting fact. If we have, side by side, two substances of different refractive power, but of the same *absolute* thickness, their apparent thicknesses, *as seen through themselves*, vary directly as the velocity with which light moves in them. Indeed, strictly speaking, the determination of minerals in the manner now described depends entirely on an indirect measurement of the velocity with which light is propagated through them in different directions.

In order to illustrate the practical applications of this method, I will describe the results obtained in the case of a section of dolerite from near Glasgow, which, on an average, is about $\frac{1}{100}$th of an inch thick.

I found that the index of a colourless transparent mineral, filling up cavities between the original minerals, was about 1·48 or 1·49. This exactly corresponds with that of analcime, with which its other optical characters agree.

Another colourless mineral, also filling cavities, was found to have the indices and other characters of calcite.

A third colourless mineral, evidently an original constituent, was seen to have a comparatively feeble double refraction, and its index was found to be 1·61. Its general appearance was like that of some felspar, but this index clearly proves that it cannot be any species which contains a considerable amount of alkali, which would greatly reduce the refractive power. The index of labradorite was not previously known, but I find that it is 1·61, and therefore there can be little doubt that the mineral in the section is that species.

The section also contains a number of transparent reddish-brown crystals, their index of refraction being about 1·79. This and their other optical characters closely agree with those of the dark augite in the lava of Vesuvius.

In now concluding this short address I cannot but feel that I have been obliged to omit all allusion to many points of considerable practical importance. I have not attempted to describe the subject in such a manner as would enable any one to at once practically apply the method in all sorts of cases. I gave a somewhat full account of one branch of the subject in my address at the meeting of the Mineralogical Society at Plymouth, and entered into the more purely microscopical aspect of the question in my late address at the anniversary meeting of the Royal Microscopical Society. I propose to communicate a detailed paper to the Royal Society as soon as a correct explanation can be discovered of certain small but remarkable discrepancies between mathematical theory and observation. My chief object now is simply to point out what valuable facts may be learned respecting the nature of any mineral by looking through it with a microscope at a circular hole or rectangular grating. This is a totally different thing to magnifying the mineral itself, or to looking through the mineral at any distant object without a microscope. The success of the method depends entirely upon the optical conditions characteristic of a compound microscope. I have lately greatly improved the apparatus hitherto employed, but the examples already given will, I trust, serve to prove that, even with the less perfect appliances, it was possible to identify in a very satisfactory manner, many of the minerals met with in their microscopical sections of rocks, and thus to determine their constitution with far more certainty than heretofore.

RECENT OBSERVATIONS UPON THE PLACENTATION OF THE SLOTHS

M. JOLY has recently brought before the Academy of Sciences of Paris the results of a careful examination of the structure of the placenta of the Aï, or Three-toed Sloth (*Bradypus tridactylus*, Linn.), and proposes important changes in classification, after comparison of this structure with that of certain allied mammals.[1]

It is now six years since we contributed to NATURE a notice of the observations of M. Alphonse Milne-Edwards upon the fœtal envelopes of another member of the Edentata, the "Tamandua" Ant-eater, published by him in the *Annales des Sciences Naturelles*. This Edentate is there stated to have a "placenta discoïdal envahissant."

The sloths are literally, as Buffon described them, ruminant animals, in that they have four stomachs, but they are, at the same time, wanting in all the other characters which pertain to Ruminants proper. Linnæus, on the contrary, classed them, at first among the Primates, but afterwards among the Bruta—the "Edéntés" of Cuvier—and his example was followed by De Blainville. Cuvier placed the "Tardigrades" (*Bradypus*) at the head of the Edentata, although they possess well-developed canine and molar teeth.

It will be seen, then, that as regards the position of these animals the embarrassment of the taxonomist has been extreme, as the genus *Bradypus* has been bandied about from the Ruminants to the Primates, and from these latter to the Edentata. Latterly, however, great importance—and with good reason—has been attributed to the structure of the placenta, as affording characters distinctive of the various groups of mammals, and as giving valuable indications of their zoological affinities. The classification of the placenta by Carl Vogt, though scarce a quarter of a century old, into zonary, diffuse, and discoidal, is nowadays acknowledged to be incomplete, nay, even faulty in some of its applications; for we know now, thanks to the work of Alphonse Milne-Edwards, that if the majority of Ruminants have a multicotyledonary placenta, the camel, the chevrotain, and the *Tragulus* have, on the other hand, one of the diffuse variety. It is the same with the digitigrade Pachyderms (wild boar, &c.), while the plantigrade ones (*Proboscidea, Hyracoidea*) differ from the first in having a zonary placenta like that of the Carnivora and Amphibia (seals, &c.). In fine, although stated to be so, this organ is neither diffuse nor subdivided among any of the Edentata studied from the point of view of their placentation. Nay, more; among these animals the placenta offers, according to genera, and even according to species, differences so well marked that it is necessary, following the apposite remark of M. Alphonse Milne-Edwards, to give up seeing between the different types of Edentata affinities as narrow as those which are supposed, even now generally, to exist among them. Carus has represented the placenta of the Aï, or three-toed sloth, as being multi-lobed, but he does not give any precise information as to the number of these lobes, their structure, the extent which they occupy relatively to the membranes of the ovum, and their connection with the uterine mucous membrane [decidua?], &c.

The placenta of the Aï examined by M. Joly presented itself under the form of a veritable membranous pouch constituted by the amnion and the chorion, and garnished, on almost all its external surface, with a large number (more than a hundred) of lobes or cotyledons of more or less irregular shape and of very variable size, from one millimetre to one or two centimetres. Viewed from the external face of the placenta, these cotyledons appear, some rounded and flat, like Nummulites, others of the form and size of seeds of millet. Others, lastly, much larger, grouped in numbers together, recall by their aspect the multi-

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[1] *Comptes Rendus*, August 12, 1878.